THE BACTERIUM *THIOPLOCA INGRICA* ON WET WALLS IN ZION NATIONAL PARK, UTAH

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ABSTRACT.— Hanging gardens and wet wall habitats have been studied for the past several years in many arid regions of the Intermountain West. One unusual large wet wall habitat in Zion National Park was found to be covered with a mucilaginous red-colored growth of the filamentous gliding bacterium *Thioploca ingrica* Visloukh. This is the only habitat we have examined where the predominant matrix-forming organism was a bacterium rather than an alga.

Hanging gardens are unusual habitats found in several areas around the world, particularly in western North America. Such habitats form when water percolates vertically through permeable rock facies (generally sandstone) until it reaches an impervious layer. The water then moves laterally until it exits the rock formation often on a vertical wall or cliff. Such exit springs often occur along fairly long horizontal lines to form linear seep walls or wet walls. Such habitats rapidly become colonized by a variety of mesic plant species, some of which are endemic to such gardens. Seep walls become weakened through time, particularly in the massive mesozoic sandstone formations typical of areas of southern Utah and northern Arizona. When this occurs, large portions of the wall slough away to form grottos that are shaded from the sun and are cooler and more humid than surrounding areas.

Such hanging garden habitats have been under study for several years (Rushforth et al. 1976, Clark and Rushforth, in press, Welsh and Moore 1965a, 1965b). We have been particularly interested in the algal species that colonize hanging garden walls. The algal floras of such habitats are variable depending upon several factors, primarily the amount of water available. The moister walls are almost always covered with heavy growth of green or blue green algae that secrete copious mucilage. Such algal mats are in turn colonized by dozens of other algal species, including blue green algae, green algae, euglenophytes, golden algae, and diatoms. Algal diversity is really quite high in many of these gardens, and the species are often unusual in morphology and/or distribution.

We have found that wet wall faces that are exposed to the sun are often colonized by algae with dominant nonchlorophylous pigments. Thus, on certain walls, the green alga *Palmella miniata* Leiblein is common. This organism is often a deep red color due to hematochrome pigments, and in turn the garden walls colonized by these organisms are often a beautiful brick-red color. Likewise, *Scytonema myochrous* (Dillw.) C. A. Agardh and *Scytonema alatum* (Carm.) Borzi are prevalent on some walls. These organisms are large, prominently ensheathed blue green algae. The sheath and the cell wall of these algae become colored as the organisms mature to form yellow or yellow brown filaments which also color their walls of colonization.

Recently, we have been studying algae and lichens of Zion National Park. One prominent wet wall in the park is Weeping Rock (Fig. 1), a famous tourist attraction. This wall is very large and is usually very moist. It is heavily colonized by many algal species. In several places on the wall, bright orange red patches and streaks are evident. We collected specimens from these areas expecting to find *Palmella miniata*. Upon returning to the lab-

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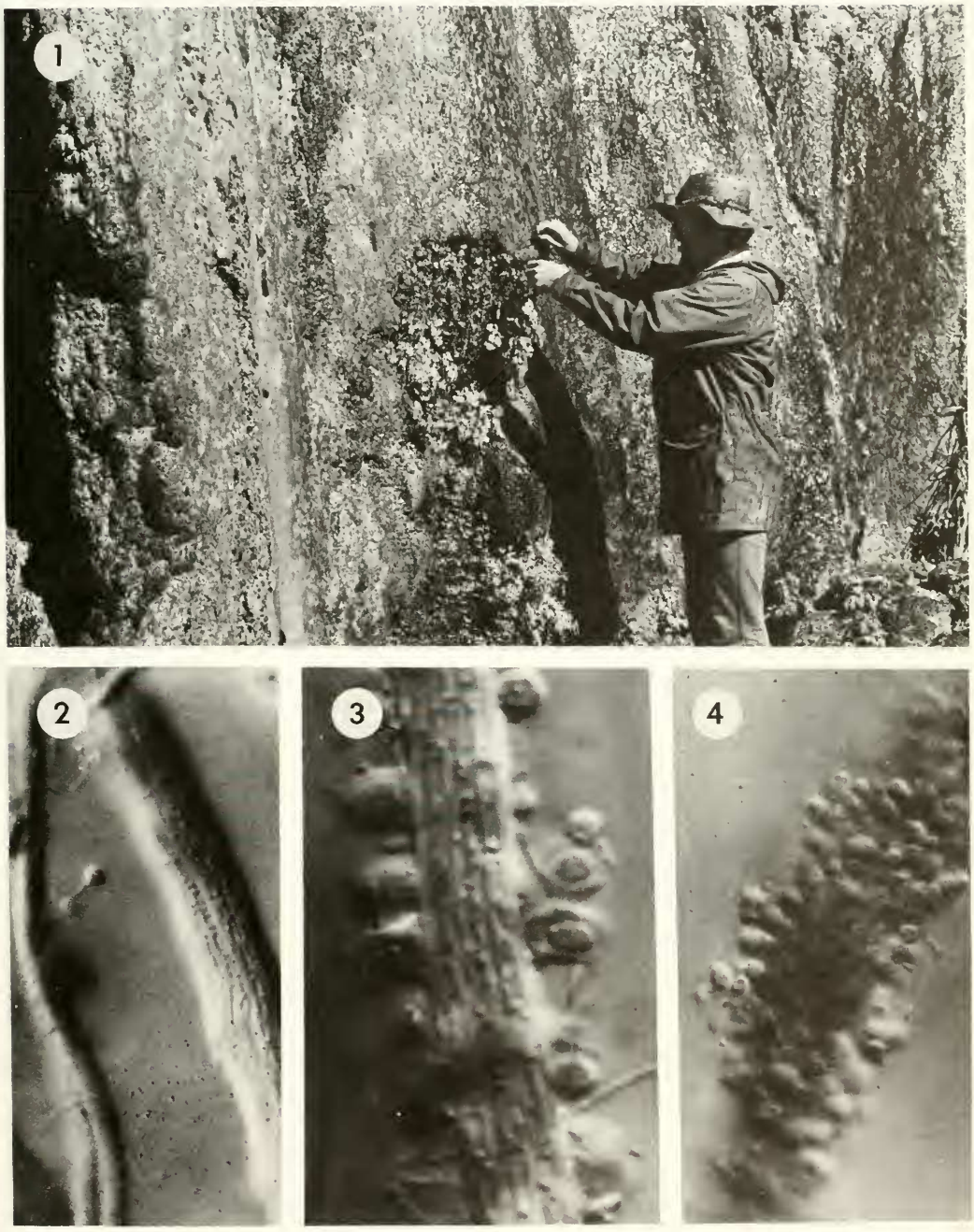

Fig. 1–4. 1, Habit of *Thioploca* and algal communities of Weeping Rock, Zion National Park; 2, "Braid" of *Thioploca ingrica* filaments in a common sheath; 3, *Thioploca* with *Chamaesiphon* species attached; 4, Low magnification photograph showing heavy epiphytic growth of *Chamaesiphon* species.

oratory, we examined the organisms using a Zeiss RA Research microscope with Nomarski differential phase contrast accessories. We were surprised to find that the red coloration was not due to *Palmella* but to a filamentous prokaryote. Careful study eliminated known blue green algae as the causal organism. Further examination showed the organism to be a bacterium in the family Beggiatoaceae Migula. These bacteria are gram-negative filaments that are motile by gliding motion. Three genera are presently placed in this family: *Beggiatoa* Trevisan, *Vitreoscilla* Pringsheim, and *Thioploca* Lauterborn. In addition, the three genera *Bactoscilla* Pringsheim, *Flexoscilla* Pringsheim, and *Thiospirillopsis* Uphof are possible members of the family (Leadbetter 1974).

The organisms we collected from Weeping Rock in Zion National Park may be placed in the genus *Thioploca*, based upon the presence of more than one filament in the sheaths (Figs. 2–4). Furthermore, the filaments ranged between the width of 2 and 7 um, placing them in *Thioploca ingrica* Visloukh. The filaments often served as a substrate for epiphytic algae, particularly *Chamaesiphon* species (Fig. 3).

This observation of *T. ingrica* is interesting for several reasons. First, it represents the only example in the several gardens we have studied where the predominant mucilaginous, matrix-forming organism was a bacterium rather than an alga. Second, it represents the only reported occurrence of *Thioploca* from intermountain western North America that we are aware of. Third, *Thioploca* usually exhibits a greenish blue color. However, the specimens we have collected produce a bright orange red color on the wall itself and a paler orange color when examined beneath the microscope. The nature of this color is unknown, although Beggiatoaceae are reported to not form carotenoid pigments. And fourth, the presence of this organism on the moist walls is itself unusual because all the reports to date that we are aware of chronicle *Thioploca* species as inhabiting the upper layers of bottom muds of freshwater and brackish habitats (Maier 1974). Specifically, such organisms have been collected from both oxidizing and reducing environments in such muds (Perfil'ev et al. 1965).

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